THE REJUVENATION OF ORCHARDS

REPORT OF SPRAYING EXPERIMENTS IN SOUTH-EASTERN OHIO—1910.

OHIO
Agricultural Experiment Station

WOOSTER, OHIO, U. S. A., DECEMBER, 1910.

BULLETIN 224

Sprayed with standard Bordeaux

Sprayed with lime-sulfur

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THE REJUVENATION OF ORCHARDS

REPORT OF SPRAYING EXPERIMENTS IN SOUTH-EASTERN OHIO—1910.

By F. H. BALLOU

Explanatory: The work of the Horticultural Department of the Ohio Experiment Station, reported in the pages which follow, was conducted, during the season of 1910, under conditions existing in south-eastern Ohio—an area of which Washington county may be said to be the center and characteristically representative.

While the weather conditions of the spring of 1910 were very trying in this particular part of Ohio, the cold was still more severe farther north and west, practically cutting off the apple crop in the north-central, western and south-western counties. The cold was somewhat less severe in the more southern counties of the state where, with a few exceptions, a record-breaking crop of apples of fine quality was harvested.

It may be well, in addition, to explain that the first work done by the Experiment Station in south-eastern Ohio was during the season of 1909, when three small experiments in spraying were conducted at Belpre, Little Hocking and Armenia (see Bulletin No. 217). At that time there had been no thorough, scientific spraying done by individual orchard owners in this once famous apple-growing section. Destructive insects and fungous diseases had, for ten years or more, destroyed the crops annually.

The Station's initial work in 1909 brought marvelous results in sound, beautiful fruit and an abundance of it, while the unsprayed orchards, as before, bore but very light crops of worthless, scabby culls.

In 1910 many orchard owners, determined to benefit by the object lessons which they closely observed in the Station's work of 1909, purchased spray outfits and did valiant battle against their now recognized enemies, codling worms, apple scab and sooty

fungus. While the extreme cold of April and May, after a summer-like March, promised for a time to destroy the crop, it was later discovered that many orchards contained all the apples the trees should carry. A summary of the results of the work of a number of these individual growers is given elsewhere in this Bulletin.

The initial work of 1909 being only to pave the way to a broader scope of service, the Horticultural Department, early in the spring of 1910, began a series of orchard experiments in Washington and eastern Athens counties. These experiments, which will require a number of years to complete, are (1) for the purpose of comparing different methods of orchard culture under various conditions; (2) to determine the practicability of the use of commercial fertilizers, in combination with cover crop culture and mulching, in improvement of the soils of orchards (Bulletin No. 171); and (3) to compare different spray mixtures.

This newly established orchard work embraces nearly fifty acres of platted orchard blocks, at eight different places and on soils ranging from warm, sandy and gravelly, on second bottom Ohio river valley land, through the heavy red clay slopes to the thin and, in some cases very poor land on the hill-tops.

While the cultural and fertilizer work are already exhibiting promise of interesting results for the not far distant future, it is with the results of the spraying operations of 1910 that this report is especially designed to deal.

GENERAL OBSERVATIONS IN SOUTH-EASTERN OHIO.

From a cultural standpoint there is no part of the average farm of southeastern Ohio that has been more abused than the orchard area. In addition to the drain upon the resources of the soil incident to the early days of heavy fruit bearing, the farm orchard has too generally been subject to imprudent cultural practice, being cropped with grain and forage plants or used as a pasture-lot in which stock has kept the ground barren to the parching, baking influence of the summer sun, and deep freezing of the soil in winters of unusual severity.

There are hundreds of apple orchards in this part of Ohio that are gradually dying from lack of nourishment. Notwithstanding the great issue of insect and fungus control, the most serious, overshadowing problem in these orchards is how to return to the impoverished soils a measure of the fertility and humus that originally existed, and to coax back to health and vigor the faithful, suffering trees, so long and seriously neglected.

In the section under special consideration, the lack of vitality of orchards did more to bring about the partial loss of the apple crop

in 1910 than did the unusual cold of April and May. Almost without exception the orchards on comparatively good soil, even individual trees occupying especially favorable spots in impoverished orchards, persistently held their fruit through all the hardships of the season, and the fruit, where properly sprayed, was as fine as any ever grown in Ohio or any other state, appearance, texture and flavor being taken into consideration.

However, in spite of the important and far reaching question of caring for and feeding orchards, the interest of the present continues to center in spraying. Along this line there is a remarkable awakening. The insects and fungous diseases will not permit sound, perfect fruit to be grown without spraying for their control; and the time is almost here when there will be a general acknowledgment of this truth as well as a general effort to combat these enemies. The orchard-owner, who fails to meet the obstacles interposed by Nature between himself and generous crops of perfect fruit, will be forced to buy the fruit used by his family or do without.

For many years Bordeaux mixture has been the most efficient known preventive of fungous diseases of the apple and other trees and plants. Bordeaux, however, has never been regarded by experts as a perfect spray. Under certain weather conditions (low temperature, cloudiness and excessive moisture) which are likely to prevail during the season of the year in which the earlier sprayings are made, the use of Bordeaux has usually been followed by more or less injury to the foliage of the apple, causing it to turn yellow and drop during the month of June, and to the fruit which would be more or less russeted, thereby detracting from its appearance and market value. In recent years this element of danger in Bordeaux has become more and more marked, although under favorable conditions it has continued to give excellent results. Doubtless there are a number of reasons why this tendency of Bordeaux to injure foliage and fruit of the apple is increasing.

In general, it may be well to suggest that the extent of injury by Bordeaux corresponds to the lack of vigor of the trees on which it is used. The great lesson of the year is that vitality means resistance in no small measure to adverse weather conditions and to the injuries of Bordeaux. Certain varieties, too, as is generally well known, are more susceptible to spray injury than others.

Orchards which have been stimulated to heavy fruit-bearing by spraying, and which have not been manured, mulched or cultivated, to maintain fertility and good physical character of the soil, are year by year surely declining in vigor, though so gradually, perhaps, that the owner may fail to realize the fact.

As the vitality of such orchards has waned, just in the same ratio have we noted increased trouble, year by year, from injury by Bordeaux mixture, when weather conditions are not favorable. Likewise, where orchards have been neglected year after year, no spraying being done to control fungous diseases which lower the vitality of the trees by premature defoliation, we note that Bordeaux. under certain weather conditions which tend to check growth of foliage and development of the newly set fruits, is almost, if not quite, as harmful in its effects as could possibly be the disease for which it is applied. This was clearly demonstrated in a number of instances in south-eastern Ohio in the season of 1910. The only conditions under which Bordeaux is a perfect spray is where the varieties are those which are not easily subject to its caustic action or where the trees possess an ample degree of vigor to resist its dangerous properties.

Naturally, under these conditions, there has been a diligent search by scientific workers in the field of plant disease control, to discover a fungicidal spray that combines effectiveness with safety. The lime-sulfur spray, aside from being the present standard remedy for San Jose scale, if applied in strong solution when the trees are dormant, is proving most effective as a fungicide, when used in more dilute form.

Moreover, the lime-sulfur spray possesses a distinctly invigorating influence upon the trees, even under the most trying circumstances. This truth will be brought out clearly in succeeding pages, embracing, detailed report of spraying work in Washington county.

Never, in our experience in spraying, has the Bordeaux been so destructive to foliage and so injurious to the apples by russeting, as in the season of 1910 in the Station's experimental work in south-eastern Ohio. It is believed that this was due, at least in part, to the extreme cold of April and early May, with a temperature below freezing at several times during the blossoming season, as the little apples were setting. Having been forced into growth during the extremely warm weather of March, the succeeding extended period of severe cold was so great a shock to the trees, so abrupt a check to their unfolding foliage and opening blossoms, as to seriously impair their vigor. This check in growth of the foliage and early development of fruit resulted in a condition most favorable for the severest possible injury to the foliage and little apples by the Bordeaux spray.

The orchards situated on the thinner, poorer soils suffered extremely, not alone from the cold but by both cold and Bordeaux injury. Indeed, extreme injury by cold and Bordeaux came as a double affliction—a twin disaster in varying degrees of intensity to orchards suffering from lack of nourishment.

On the other hand, where the lime-sulfur mixture was used in comparison with Bordeaux, even upon trees growing on the poorest, thinnest land on which spraying experiments were conducted, the lime-sulfur sprayed trees were so superior in foliage growth that the difference could be distinguished as far as the orchards could be seen. There was not only more abundant and luxuriant foliage, but more and better fruit on the lime-sulfur than on the Bordeaux plots. Both foliage and fruit were clean and healthy and at no time during the season was there the least dropping of leaves or loss of fruit from effects of spraying with lime-sulfur mixture. Clearly and unmistakably the lime-sulfur spray exerted a decidedly invigorating effect. Where used on orchards situated on fertile soils, and on varieties not especially subject to spray injury, such as Rome Beauty and York Imperial, there was less difference in favor of lime-sulfur; but, in every case in the Station's spraying tests, the lime-sulfur was superior, in a greater or lesser degree, to the Bordeaux.

The extensive trial of the lime-sulfur spray in south-eastern Ohio, during the season of 1910, under many conditions of soil and elevation and on quite a number of better known varieties of apples, and its comparison with Bordeaux of various strengths, warrants the recommending of the substitution of lime-sulfur for Bordeaux mixture. This comparatively new spray, in combination with the usual arsenical poison (arsenate of lead) for insect control, seems as nearly ideal as can well be imagined.

The lime-sulfur used in our Experiment Station work of 1910, in south-eastern Ohio orchards, was the commercial, concentrated product put up by one of several chemical supply houses. It comes in 25 and 50 gallon barrels. It was used at the rate of 1 1-2 gallon of the concentrated mixture to 48 1-2 gallons of water. From the most excellent results of this strength the writer is constrained to believe that a somewhat more dilute mixture will give equally good results, and in the future will recommend and use 1 1-4 gallon of the concentrated solution to 48 3-4 gallons of water. It is less trouble to prepare the lime-sulfur than Bordeaux, where the commercial solution is used, it being a simple matter of dilution and addition of the arsenate of lead at the usual rate—2 to 2 1-2 lbs. to 50 gallons of prepared spray mixture.

The following report of spraying experiments presents more in detail facts and illustrations which confirm the foregoing statements of observations and conclusions.

DETAILS OF SPRAYING EXPERIMENTS IN SOUTH-EASTERN OHIO IN 1910

The prematurely warm, summerlike weather prevailing throughout the greater part of the month of March, 1910, involved the orchardists of south-eastern Ohio, who were planning to spray, in all manner of perplexity. "Rush" orders for spraying materials were hurled at the chemical supply firms in such number that these firms were "deluged" with orders which could, of course, be filled only in rotation. The materials were soon exhausted and could not be made or procured nearly so fast as demanded. This constituted lesson No. 1 of the season, both to the orchardists and the dealers in chemical supplies; impressing the need of ordering spraying materials far in advance of the spraying season and of being ready to meet the demand.

The Horticultural Department of the Station was equally unprepared for the premature burst of summer weather, and the earlier flowering varieties of apples, in the various orchards platted for spraying experiments, were coming into foliage and showing color in the blossom buds by the time the spray pumps could be started.

So much interest was manifested by orchard owners who had equiped themselves for spraying, but had never had experience in making spray mixtures, that the opportunity was given these men to meet at the various orchards in which the Station was starting spraying experiments, for the purpose of enabling them to see the mixtures made and applied, and to ask any questions which might occur to them relative to the work. This plan did not seriously hinder the Station's operations and promised to prevent many beginners from making mistakes which might prove to be discouraging. There having been practically no spraying done by private growers previous to this time, it was indeed surprising, and encouraging as well, when, at the end of the first week's spraying in our Station test plots, our note-book exhibited the fact that 240 men had gathered at six of the eight different orchards in which spraying was started. Some of these men drove 18 or 20 miles in order to see the work done and, perhaps, to ask a number of questions.

The extremely warm weather which will cause March, 1910, long to be remembered, continued until April 4th, on which date the first spraying was done during an unusually strong wind, with rain threatening. On April 5th, the wind continued, making spraying very difficult. At this date the blossoms of Grimes and Ben Davis were opening so rapidly that spraying of these varieties

had to be discontinued and work on the later flowering Rome Beauty taken up. On April 6th, the high wind continued, with rapidly falling temperature and a cold rain at night. On April 7th, the continuing heavy wind had attained a degree of cold that work in the orchard was attended with considerable discomfort. A heavy frost, with temperature well below freezing, came during the night of the 7th, and the morning of the 8th exhibited much foliage of the less hardy native trees, shrubs and plants, drooping and blackened. The apple blossoms, too, except on well nourished trees where the more luxuriant foliage and greater vigor had combined to save them, appeared limp, sickly and dull in color.

Notwithstanding the retarding influence of the low temperature spraying had to be temporarily abandoned at this time, on account of the blooming period of the later flowering varieties.

On April 19th, the petals of the blossoms of the early flowering varieties had fallen and spraying was continued. A cold rain with temperature falling to the freezing point came at night. Cold, cloudy weather with frequent rains rendered spraying slow and unpleasant work until April 27th, when temporary relief came in warm and brighter weather. An all day rain on May 3rd was followed by returning cold on May 4th. The mercury dropped to freezing at night. Though the cold was discouraging in the extreme spraying was continued. On the night of May 5th a severe frost and freeze came, killing many of the more tender garden plants, cutting off hundreds of acres of potato plants in this section and, as it proved, ruining the apple crop in all north central and western Ohio, except in well favored situations.

The young apples in south-eastern Ohio were the size of large peas and were frozen in a number of orchards where scanty foliage and low vigor of trees afforded little protection and resistance. Current reports at once proclaimed the apples all killed, and it was not difficult to believe that this might be only too true, but the Station spraying work was continued until May 10th, with daily increasing belief that there was much fruit uninjured, At this time, however, reports from various sections of Washington county became so conflicting that a very careful inspection of orchards throughout this section was begun by the writer. The results of this very interesting investigation indicated that the apple crop in the Washington county area, after all the hardship through which it was forced to pass, would be a generous one. True, there were several orchards in which there was not a live apple left. A number of the orchards suffering the greatest destruction by the cold of April and May were those situated at considerable elevation, with

most excellent frost drainage afforded by adjacent lower levels and ravines. Other orchards at no great distance, and ranging in elevation from second bottom land in the Ohio valley to the highest hill-tops, came through the frigid ordeal with from fair to abundant crops of apples. A very careful analysis of the data gathered revealed the truth that, as a rule, those orchards situated on the poorest land and weakened by disease and from lack of nourishment were the orchards which suffered correspondingly in loss of fruit by cold.

This early investigation, moreover, disclosed positive evidence that Bordeaux injury was very prevalent, and that its intensity seemed to correspond to the loss of fruit by cold. The little apples, no larger than peas, were already showing the brown marks of Bordeaux injury. Where the orchards were situated on soil so poor that the trees were in a condition of starvation, all the fruit was gone, even though the trees had blossomed freely. Wherever the fruit had been totally destroyed by cold or the combined effects of cold and Bordeaux injury, the foliage had also suffered extremely from the application of Bordeaux at a time when the starving trees were in the grip of the growth-retarding cold.

In marked contrast to the above described conditions prevailing in Bordeaux sprayed plots, the plots sprayed with lime-sulfur were clearly much superior in every particular. Where the combined effects of low physical condition of the trees, cold and Bordeaux injury had caused a partial loss of fruit, the lime-sulfur plots showed plenty of smooth, perfect fruit and abundant, luxuriant foliage. The lime-sulfur spraying, in other words, saved the crop of apples under those particular conditions which resulted in a partial loss by cold and Bordeaux. Where the cold was more intense and the physical condition of the trees extremely low, resulting in the loss of crops in both Bordeaux and lime-sulfur plots, there was abundant evidence that the foliage of the trees on the lime-sulfur plots was far superior to that on the trees of the Bordeaux plots, suggesting to the observer that the lime-sulfur sprayed plots had been given a generous application of a quickly available and nourishing plant food.

In all of the Station's test plots in spraying it was evident that the poorer the soil and the lower the physical condition of the trees, the more marked were the beneficial effects of lime-sulfur as compared with Bordeaux.

RESULTS OF SPRAYING EXPERIMENTS AT TORCH, EASTERN ATHENS COUNTY

ORCHARD OWNED BY J E. FULTZ

This is one of the most excellent orchards for experimental work in south-eastern Ohio, embracing, as it does, in the area chosen by the Horticultural Department for culture, mulching, fertilizer and spraying work, over 400 Rome Beauty trees seventeen years planted. The location is at a moderate elevation with good soil and air drainage, the ground sloping gently to the south. The soil of the area is uniformly thin from the growing of farm crops previous to and during the first eight years of the life of the orchard. The trees had suffered much from annual, premature defoliation, by apple scab fungus and other troubles. The orchard was double platted, the spray-test plots extending crosswise and including a part of each culture plot. The spraying work consisted of a comparison of the following named spray mixtures: (1) Standard Bordeaux; (2) half-strength Bordeaux; (3) Bordeaux and iron sticker; (4) commercial lime-sulfur; (5) check or unsprayed trees. First spraying, April 23 to 27. Second spraying, May 17 to 20.

Unfortunately this was one of the orchards which suffered severely from cold, there being left a much-thinned crop which, however, afforded an opportunity for comparing results of spraying and demonstrated splendid possibilities for the future when more favorable conditions prevail. But there were certain object lessons in this orchard for which we are indebted to the cold, which we cannot afford to pass by unnoticed. While the crop, throughout the general area of the orchard was very light and scattered, there is a row of trees at the west side, standing close to and parallel with the fence separating the orchard from an adjoining field (See Fig. 1). This strip of ground, an old fence-row, is comparatively fertile, never having been subjected to a hard system of farm crop production, as had the orchard area previous to and during the early years of the orchard's existence. This west row is the most exposed to the cold and hard winds of all the orchard; yet the trees in this row are nearly or quite double the size of those in the second row but 30 feet farther east. Not only are the fence-row trees much larger, but the foliage was so much more luxuriant and dark that the contrast with the second row and remainder of the orchard could be clearly seen from the railroad one-fourth of a mile south. The better nourished trees, moreover, *produced a generous crop of fruit*, while the rows adjoining gave but a few scattered specimens. Farther over in the orchard stood a tree of Rome Beauty near a pile of brush which for four years has been covering a small spot of

ground and decaying (See Fig. 2). This pile of brush, acting as a mulch upon only a small area of soil near which the apple tree stands, so assisted in the nourishment of the fruit tree that it produced nearly a full crop of excellent apples, while the other trees surrounding it, although they blossomed just as profusely, lost practically all of their fruit by the cold.

These two illustrations, of the close relationship of vigor to the ability of a tree or an orchard to withstand hardship from weather conditions, were as clearly marked as the most conservative investigator could desire.

As before stated, this orchard is composed of Rome Beauties, there being a few trees of other varieties at the north end. The fruit of the Rome Beauty being one of the most resistant varieties to injury (russeting) by spraying, there was practically no loss of fruit from Bordeaux injury, although a considerable percentage showed slight veinings, or nettings, of the characteristic russet marking. It has been asserted by a number of apple growers and writers that the serious russeting of the fruit in 1910 was wholly due to the effect of the cold wet spring, and that the kind of spray used had little to do with the extent of injury. While in some parts of Ohio this may have appeared to be true, it was far from being the case in the Washington county area, as the detailed statement of results will exhibit, wherever the Station conducted spraying tests.

TABLE SHOWING RESULTS OF USING DIFFERENT SPRAY MIXTURES, AT TORCH

Rome Beauty sprayed with	Foliage injury	Fruit slightly russeted	Fruit slightly scabbed
	Percent	Percent	Percent
Standard Bordeaux	33	82	13
Half strength Bordeaux	25	72	39
Bordeaux and iron sticker	20	77	35
Commercial lime-sulfur	.	32	13
Unsprayed trees		.	93

Note: While the above table would suggest that there was a considerable percentage of scab on the sprayed fruit, it will be well to explain that by far the greater number of apples placed in the scabbed grade were so very slightly marked that they would readily pass in the No 1 marketable grade. The unsprayed fruit was so seriously scabbed that it was worthless.

Fig. 1. Well nourished Rome Beauty trees along an old fence-row, bearing a generous crop of apples. The fruit on the poorly nourished trees in second row was nearly all killed by cold. Spring of 1910.

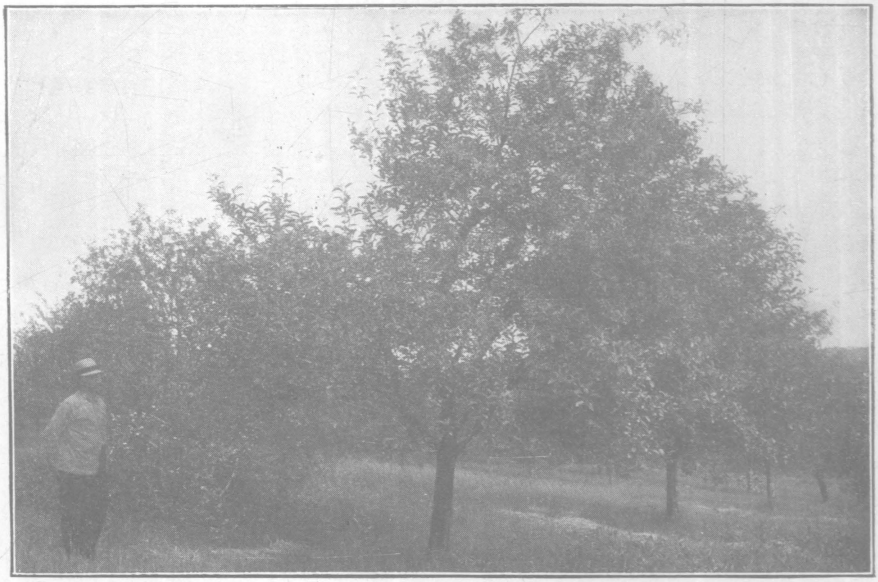


Fig. 2. A Rome Beauty tree standing near where a brush heap has been lying and decaying for four years. This tree bore heavily while nearby trees lost their crops by cold. Spring of 1910.

RESULTS OF SPRAYING EXPERIMENTS AT CENTER BELPRE

ORCHARD OWNED BY I. T. LEWIS

This small but beautiful and unusually interesting Rome Beauty orchard, perhaps 20 or more years old (owner is not sure of age) is situated on level, second-bottom land near the Ohio river. The orchard of a few over 100 trees is divided into sections by the right-of-way of the B. & O. S. W. R. R. which extends east and west through the central part. The southern section of the orchard lies nearest to Mr. Lewis's home and farm buildings and has for years been used as a feed-lot for swine. The soil is, therefore, well supplied with fertility and the trees are very large and vigorous. The section lying north of the railway tracks is an unfenced part of an area of land that has been subject to farm crop production and pasturing. The ground, like that of the south plot, is a warm sand, but through cropping the humus and fertility have been depleted Both sections have been seriously subject to infestation by apple scab fungus, the foliage and fruit being destroyed year after year. It is quite evident that the part of the orchard on the less fertile soil would, and did, suffer most from this disease and it was the fact, that this portion was one of the blocks of apple trees found in 1909 most seriously diseased (with apple scab) that led to a determination to arrange with the owner for a small spraying and culture experiment in 1910.

On the 16th day of September, 1909, the writer visited and photographed this section of the orchard, which was at that time almost destitute of foliage. The ground was covered, with leaves which were yellow and spotted, and the few leaves on the trees showed the same characteristic markings of disease. The few apples on the trees were dwarfed and deformed by scab.

While the trees in this section were low in vitality, from effects of comparatively poor soil and seriously diseased condition, they blossomed freely in the Spring of 1910. One half of the orchard was sprayed with standard Bordeaux mixture and one-half with commercial lime-sulfur. Three sprayings were made—April 6th, before the time of blooming, April 28th and May 21st. The extreme cold of April and May came near rendering the fruit a minus quantity, although enough was left not only to show the good results of spraying, but to much more than repay all cost of materials and labor. Notwithstanding the destruction wrought by apple scab fungus for years past, the spraying of 1910 almost completely prevented the appearance of this trouble. There was scarcely a trace of fully developed scab, either in the Bordeaux or lime-sulfur sprayed plots, so little, in fact, that it was not deemed

necessary to take it into consideration when grading and examining the fruit in an effort to determine the extent of injury by Bordeaux as compared with lime-sulfur. The variety being Rome Beauty, the injury by Bordeaux was not serious, yet there was a prevalence of netting and veining of russet, with an occasional deformity, caused by the Bordeaux, that was almost wholly absent in the lime-sulfur sprayed fruit. The following table will show this comparison in figures obtained by careful grading of the products of several representative trees in each plot:

TABLE SHOWING RESULTS OF SPRAYING AT CENTER BELPRE

Rome Beauty sprayed with	Foliage injury	Fruit slightly russeted
	Percent	Percent
Standard Bordeaux	25	57
Lime-sulfur		43*

*But much less noticeable than in Bordeaux spraying.

As the figures indicate, there was considerable spotting and dropping of foliage in June from spray injury by Bordeaux, although the trees recovered from this loss to a great degree and presented a vigorous appearance throughout all the latter part of the growing season. In the lime-sulfur plot there was not the least injury to or dropping of foliage at any time during the season. The trees were, at all times, the picture of health and luxuriance. This orchard was again photographed, on the 15th day of October, 1910, or one month later than the date on which it was photographed from the same place in 1909. These two pictures compared will show the improvement in foliage from the one season's effectual spraying.

While the Station's spraying work in the poorer north section of this orchard was in progress, Mr. Lewis was spraying the more fertile, south section, using standard Bordeaux and doing thorough work. Here, the trees being well fed and comparatively vigorous, there was scarcely a trace of Bordeaux injury, either to foliage or fruit, while the cold of April and May caused but little loss of fruit. A generous crop of very large, fine Rome Beauties was harvested, some of the apples measuring 12 inches in circumference, and a few 13 inches.

Here, again, was the lesson clearly pointed, that the orchard on the better soil, though of the same variety and planted at the same time, possessed, in a marked degree, much greater resistance to cold and the caustic action of sprays than those less well fed. This lesson will be further emphasized by a comparison of the more fertile section, in which the Lewis orchard is located, with the orchard next described.

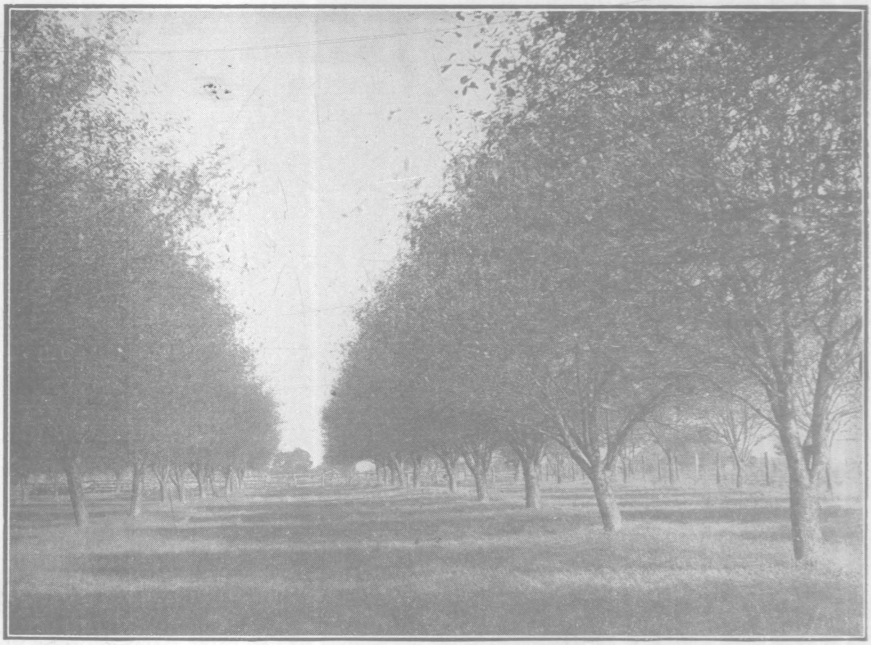


Fig. 3. Photo taken in Lewis orchard September 16, 1909, showing Rome Beauty trees practically defoliated by apple scab fungus. No spraying had been done.

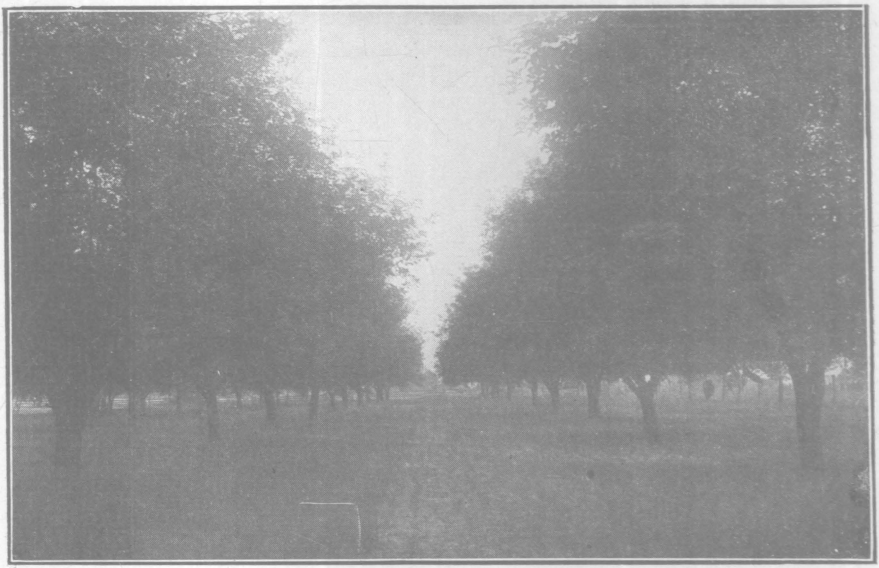


Fig. 4. Photo taken in Lewis orchard October 15, 1910, after one season's spraying. Foliage heavy and clean with no scab to be found.

RESULTS OF SPRAYING AT FLEMING, OHIO

ORCHARD OWNED BY S. L CANFIELD

This orchard of the Rome Beauty variety is situated several miles from the Lewis orchard and back from the river, on very thin upland—the summit of one of many ridges between which deep ravines abound. The situation, so far as cold air, or frost-drainage, is concerned, is almost ideal. The degree of cold in this area was, however, apparently somewhat more severe than in the valley of the Ohio or on the hills immediately bordering the valley. The trees of this orchard, aside from having suffered infestation by apple scab for a number of years, were in very low condition from lack of plant food. The ground had been cultivated in farm crops as long as such crops were sufficiently productive to justify the labor put upon them, and the trees had been left to exist on the limited amount of plant food remaining. The trees blossomed freely in the Spring of 1910, in spite of their very weak physical condition. Two sprayings were given, the first April 7th, before blooming, and the second April 28th, after the petals (and practically all the fruit) had dropped. The comparison of spray mixtures here was between standard and three-quarter strength Bordeaux. It has been a continual regret to the writer that lime-sulfur was not included in this experiment, for the excellent effect that it most certainly would have exhibited in promoting luxuriant foliage development, even though no fruit might have been saved by its use. However, practically the same conditions of soil and disease infestation prevailed here as in the New Matamoras orchard where lime-sulfur was used, to which results, recorded in the next chapter, the reader's attention is directed.

The effects of cold and lack of nourishment for the trees, together with the havoc wrought by the Bordeaux mixture as the result of low vitality and the severe check by the cold, entirely destroyed the crop in prospect, and the trees, throughout the growing season, showed a very scanty development of very small weak foliage. Not a single apple, so far as the writer could observe, was left in this orchard. This total loss could not be attributed to lack of pollenation of blossoms, for a row of trees of other varieties, outside of the plot sprayed, would meet any possible requirement of this nature.

Comparison of this orchard with the south, or more fertile section of the Lewis orchard, (the part sprayed by Mr. Lewis himself) is mentioned for the following reasons: (1) The variety is the same in both orchards; (2) the age of the trees is about the same; (3) the Bordeaux mixture was used on both; (4) the two orchards afford striking examples of the effects of generous nourishment as against semi-starvation.

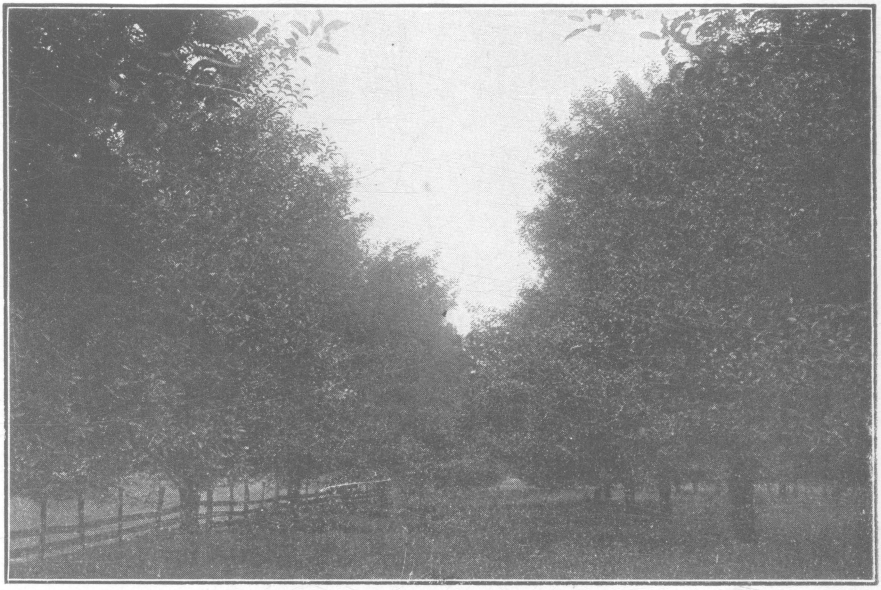


Fig. 5. South section of Lewis orchard Fertile soil. But little loss of fruit by cold and but slight injury either to foliage or fruit by Bordeaux mixture.

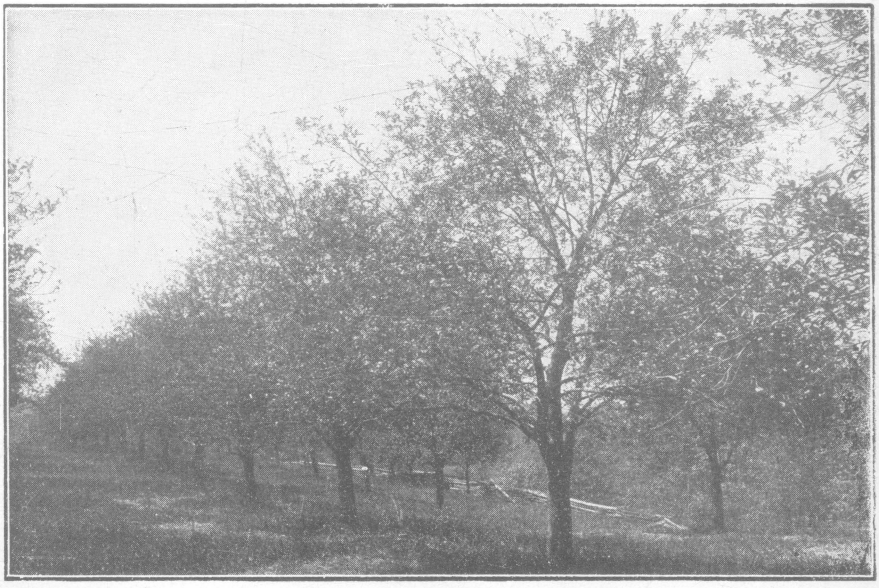


Fig 6. Canfield orchard. Poor soil. Total loss of fruit and severe injury to foliage by combined effects of cold and Bordeaux. Trees same age, same variety and had same treatment as those in south section of Lewis orchard. Both photos taken same day, in June.

The difference in effect, in the Canfield orchard, between the standard Bordeaux (4-6-50) and the three-quarter strength (3-5-50), was but slight. The three-quarter strength caused, in a small degree, less injury; but both mixtures were fully as disastrous to the foliage as the apple scab fungus at its worst could possibly have been. The effects on the trees, for the season of 1911, can hardly be foretold; but the work will be continued with unusual interest, including the lime-sulfur spray, for it is just such extremely unusual and disastrous results as those of 1910, obtained in this orchard, that demand the most careful study and painstaking work. With the fertilizer and mulching experiments also started, the writer has confidence that there will be a different and more encouraging report to make on this orchard in the future.

RESULTS OF SPRAYING EXPERIMENTS AT NEW MATAMORAS

ORCHARD OF J M WALKER

This orchard is fairly comparable with the Canfield orchard just described, in that it is situated on very poor upland well surrounded by deep ravines affording cold air drainage. The variety, too, is Rome Beauty, while the trees have made little growth in recent years and have never produced any perfect fruit on account of the extreme infestation by apple scab fungus. Thousands of twigs, at the extremities of the branches, show only a series of little rings or "wrinkles," each one recording the evidence of a season's struggle of the tree to retain life under conditions serious in the extreme.

These dwarfed, stunted growths of from one-sixteenth to one-quarter of an inch per season are formed simply by the unfolding of a bud in Spring, the formation of a cluster, or rosette of leaves, the development of a new bud and no extension of wood growth. These conditions, found in many orchards in southeastern Ohio, bespeak the approach of the last stage of suffering from disease and starvation. What is done in the alleviation of their dire condition must be done promptly as it will soon be too late.

Mr. Walker is not only now keenly alive to the possibilities of apple growing in his section, but having come to an understanding of the trouble in his really beautiful orchard of Rome Beauty trees, just at the age at which they should be entering upon an era of fruitfulness and profit, is utilizing every available forkful of vegetable matter of all kinds that can be used as a mulch, the orchard being on a steep hillside where cultivation would only make a bad condition worse by washing of the soil by heavy rains. Tons of

vegetable matter of various kinds are being hauled and distributed under the outer branches of the trees. The Station also has both mulching and fertilizer experiments started in this orchard.

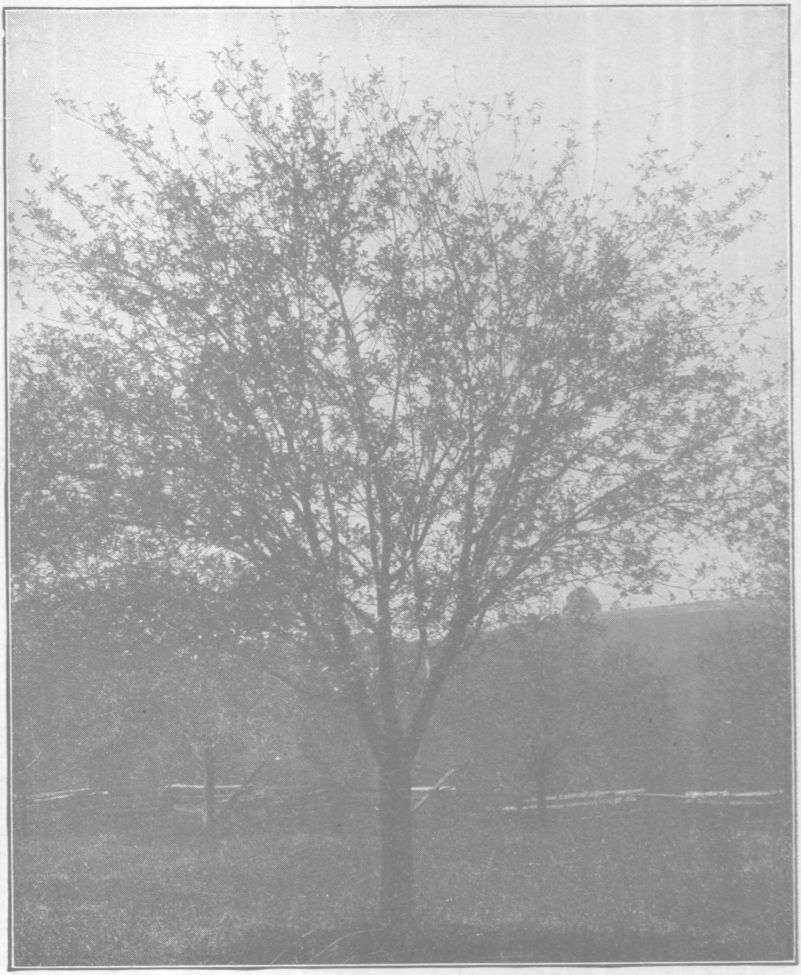


Fig. 7. A typical example of a Rome Beauty tree suffering from lack of nourishment, cold, and Bordeaux injury. No fruit and but little foliage. Canfield orchard.

As in the Canfield orchard, not an apple was left by the cold in the Walker test plots. The spraying work at this place was a comparison of standard Bordeaux with commercial lime-sulfur, two sprayings being made: April 8th, just as the color in the blossom buds was beginning to show, and the second, April 29th, soon after the petals had all dropped. An inspection of the orchard late in

May disclosed the fact that no apples were left either on the Bordeaux or lime-sulfur plots; but the orchard was not without its lesson. The striking features were the serious injury done by the Bordeaux, being very similar to that wrought by the same cause in the Canfield orchard, and the distinctly marked, beneficial effects of the lime-sulfur. The Bordeaux sprayed trees showed a very scanty development of small, sickly, spotted leaves, while the lime-sulfur sprayed trees were generously clothed in fresh, deep green, luxuriant foliage. The difference between the two plots could be seen as soon as one came in sight of the orchard. Clearly the Bordeaux had "done its worst," while the lime-sulfur had unquestionably exerted a wonderfully invigorating effect. With absolutely no fruit on the trees, the orchard was, nevertheless, abundantly fruitful by the way of a great and helpful object lesson.

Let us now pass on to a study of other spraying experiments in this same section of Ohio, where success, in greater or lesser measure, rewarded the efforts of the season with a gift of fruit, and where the results of comparisons of Bordeaux and lime-sulfur are even more striking and convincing than the ones so far recorded.

SPRAYING EXPERIMENTS IN ORCHARD No. 1 AT BELPRE (Briggs Station)

ORCHARD OWNED BY G M PREWETT

This orchard is situated at a moderate elevation overlooking the Ohio river and valley. The soil is a red, stiff clay, which outcrops abundantly in south-eastern Ohio. The varieties included in the spray test were principally Rome Beauty, Ben Davis, Stayman, Maiden Blush and Fallawater. Standard Bordeaux, three-quarter-strength Bordeaux (on Ben Davis) commercial lime-sulfur and copper sulphide (on Rome Beauty) were the sprays used in this test. Two sprayings were made, the first, April 18th to 21st, just after the blossoms had fallen, and the second, May 4th and 5th.

The portions of this orchard in which the Station's experiments were conducted were of moderate fertility except one plot of Rome Beauty, the greater part of which occupies a steep slope dropping to the north, which is almost destitute of soil because of erosion.

While the injury by standard Bordeaux prevailed in greater or lesser degree throughout the portions of the orchard fairly supplied with plant food, *extreme* injury and loss of fruit by cold, combined with effects of Bordeaux, was apparent only on the steep, thin slope referred to. Here the destruction of fruit was almost total, just as on the very poor soils at Fleming and New Matamoras.

Fig. 8. Fallawater.

Sprayed with Bordeaux
75 percent of fruit injured.

Sprayed with lime-sulfur.
No injury.

Very careful inspections of the orchard in June, July and August, with conservative estimates of results of spraying, together with careful grading and counting of fruits from a number of representative trees at apple picking time, gave the figures as presented in the following table:

Variety	Sprayed with	Injury to foliage	Injury to fruit	Scab injury
		Percent	Percent	Percent
Rome Beauty	Standard Bordeaux	50	20	8
Rome Beauty	Lime-sulfur	0	0	8
Rome Beauty	Copper sulphide	10	0	8
Rome Beauty	Unsprayed	....	....	75
Ben Davis	3-4 strength Bordeaux	60	90	5
Ben Davis	Lime-sulfur	0	10	5
Ben Davis	Unsprayed	....	....	15
Maiden Blush	Standard Bordeaux	40	10	5
Maiden Blush	Lime-sulfur	0	0	5
Maiden Blush	Unsprayed	....	....	10
Fallawater	Standard Bordeaux	50	75	3
Fallawater	Lime-sulfur	0	0	3
Fallawater	Unsprayed	....	....	12
Stayman	Standard Bordeaux	30	90	2
Stayman	Lime-sulfur	0	0	2
Stayman	Unsprayed	....	....	15

Note: The copper sulphide spray is a combination of the Bordeaux and lime-sulfur. It is usually made by the "self-boiling" process of preparing the lime-sulfur, but, in this case it was made with the concentrated, commercial lime-sulfur, using 1 gallon of the lime-sulfur, 1 lb. of copper sulphate and 2 lbs. of lime to the 50 gallons of completed spray mixture. While this proved an excellent spray, it possessed no advantages over the straight lime-sulfur and was, moreover, slightly injurious to the foliage on the Rome Beauty. It was also used on Corps Choice apple trees, somewhat injuring the foliage and producing considerable russet fruit.

The Stayman and Ben Davis were almost totally destroyed for market in the Bordeaux sprayed plots—the Staymans first russeting badly and, later on, cracking so seriously that rot started to a considerable extent. It is safe to state that the Ben Davis plot, sprayed with Bordeaux, aside from the apples being badly russeted and deformed, did not produce more than one-third as much fruit as the plot alongside, under the same conditions, sprayed with lime-sulfur. The Bordeaux, three-quarter, strength, not only cut off over one-half of the foliage and russeted the fruit seriously, but actually destroyed a large part of the newly set fruit at the first spraying. Both Stayman and Ben Davis were sound, bright, plump, and clean where the lime-sulfur was used.

Sprayed with Bordeaux, 5 percent of fruit injured

Fig. 9. Bellflower.

Sprayed with lime-sulfur 10 percent of fruit injured

RESULTS OF SPRAYING ORCHARD No. 2, BELPRE (Briggs Station)

ORCHARD OWNED BY C. R. PREWETT

In this second orchard at Briggs, chosen because it contained varieties which could not be found elsewhere in the vicinity, standard Bordeaux and lime-sulfur were compared on Yellow Transparent, Wealthy, Bellflower and Lawver apples.

Two sprayings were given, the first on April 22nd, the second May 6th. The elevation of this orchard is somewhat lower (perhaps 100 feet lower) than the orchard of G. M. Prewett; but, while the cold was probably more intense, the soil conditions and vigor of the trees were sufficiently good to enable the trees to hold their fruit excellently where lime-sulfur was used, with considerable loss in the Bordeaux spraying, both in foliage and fruit. Very careful estimates made at different times during the season, gave the results shown in the table below:

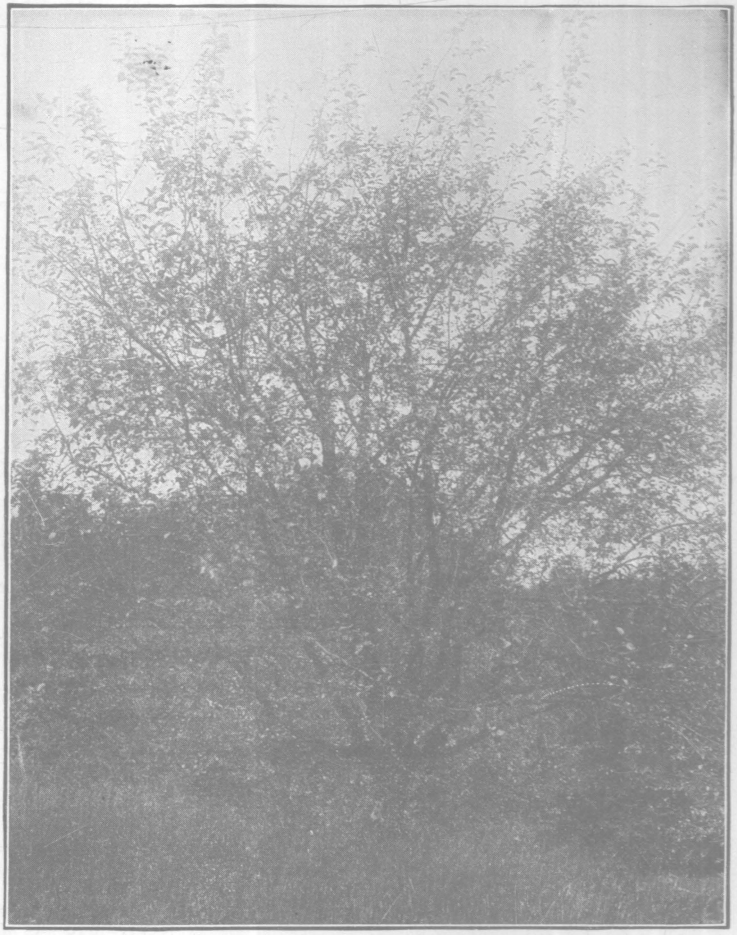


Fig. 10. Wealthy tree sprayed with Bordeaux. Foliage injury 80 percent.

Variety	Sprayed with	Injury to foliage	Injury to fruit	Scab
		Percent	Percent	Percent
Bellflower	Standard Bordeaux	50	95	4
Bellflower	Lime-sulfur	0	10	4
Lawver	Standard Bordeaux	40	60	10
Lawver	Lime-sulfur	0	0	10
Lawver	Unsprayed	....	....	80
Wealthy	Standard Bordeaux	80	50	5
Wealthy	Lime-sulfur	0	0	5
Wealthy	Unsprayed	....	....	35
Yellow Transp.	Standard Bordeaux	40	50	3
Yellow Transp.	Lime-sulfur	0	0	3
Yellow Transp	Unsprayed	..	. ..	10

Note: In the foregoing tables it will be observed that the rate of injury to fruit by apple scab fungus is given the same in both Bordeaux and lime-sulfur experiments. It will be well to state that neither by studied estimates nor by actual count at picking time was there found to be any difference in the fungicidal value of Bordeaux and commercial lime-sulfur. Both were excellent. While the percentage of specimens recorded as showing scab, in the sprayed plots, may seem in some cases more than should be, the truth remains that the markings of scab in these cases were so slight as to render them almost unnoticeable. Iu the unsprayed work, however, the scab was much more clearly in evidence, no matter whether the percentage of injury was high or low.

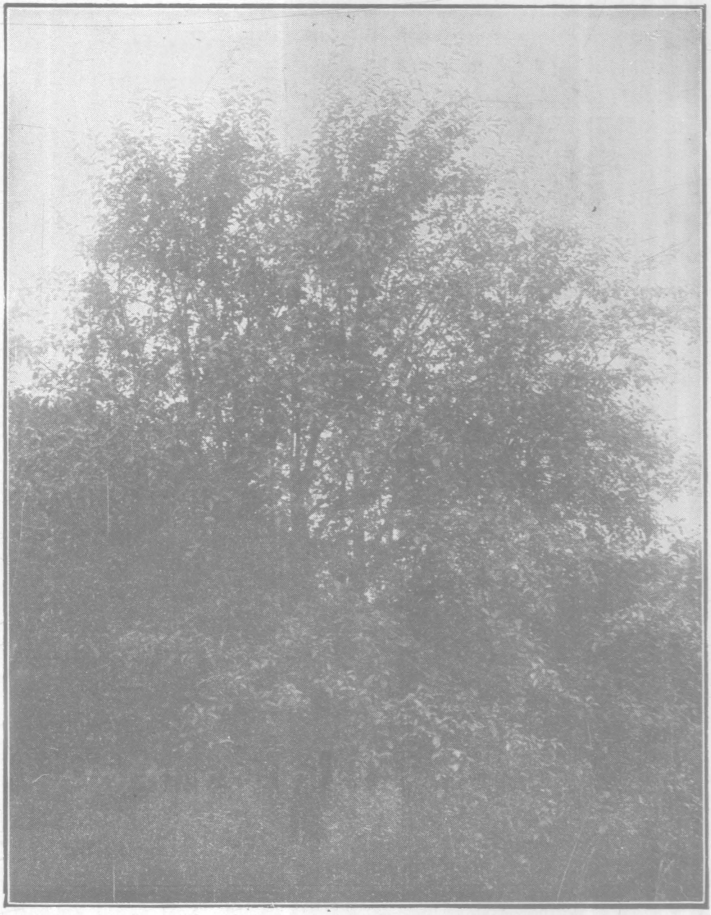


Fig. 11. Wealthy tree sprayed with lime-sulfur.
No foliage injury.

RESULTS OF SPRAYING EXPERIMENTS AT LOWELL

ORCHARD OWNED BY M. H. DYAR

This orchard is situated on a hill summit, probably 300 feet above the bed of the Muskingum river, overlooking the river and valley. The ground of the orchard area is, however, for the most part almost level. The soil is thin from former persistent cultivation in farm crops, though not so poor as the orchard areas at Fleming and New Matamoras.

No serious loss from the cold alone was suffered in this orchard, though the loss from the combined effects of cold and Bordeaux on the trees in low physical condition was discouragingly heavy, as compared with results in the lime sulfur plots under the same conditions.

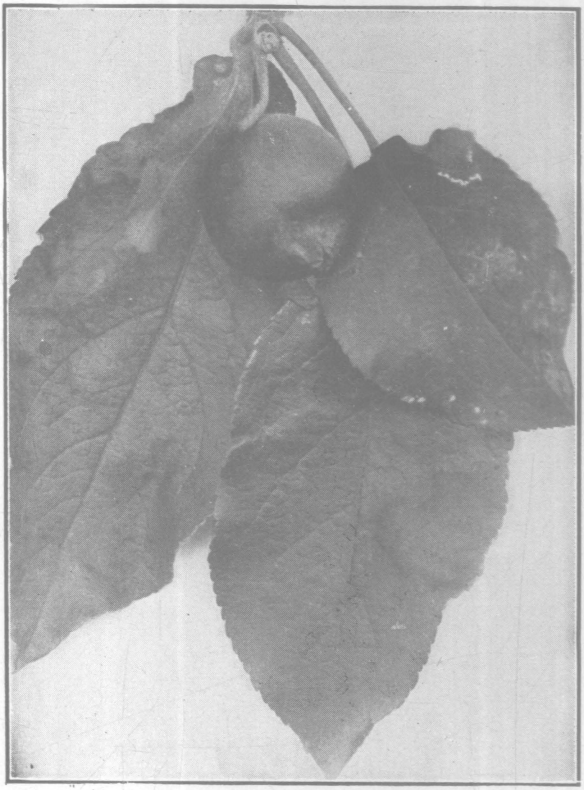


Fig. 12. An average specimen of Wealthy apple and foliage sprayed with Bordeaux. Photo taken in June. Leaves had many brown spots and areas, which do not show in photo.

The plots chosen for spraying include Grimes and Ben Davis, trees probably 20 years old. The spraying plots extended transversely across the plots in which cover crop, mulching and fertilizer work is established. Standard Bordeaux and commercial lime-sulfur were the only mixtures used in comparison here, and no check trees were left, as the experiment was designed as a special contest between these two mixtures. These plots were sprayed three times, April 5th, just as the blossoms were beginning to open, April 23rd after the petals had fallen, and May 9th.

In describing the effects of the different sprays in this orchard the writer cannot do better than to quote from his note-book in which observations were recorded on the second day of June, 1910.

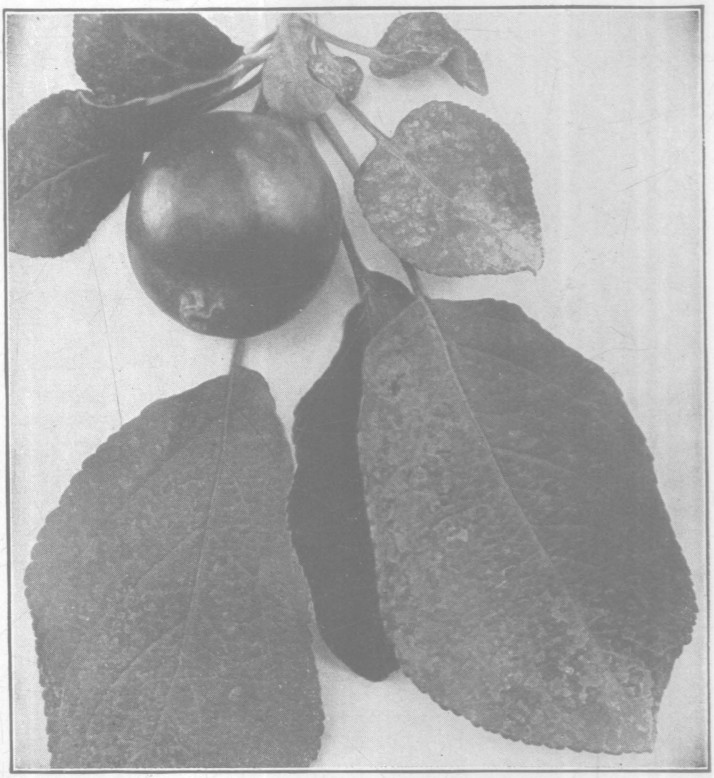


Fig. 13. An average specimen of Wealthy apple and foliage sprayed with lime-sulfur. Photo taken in June, same day as that shown in Fig. 12. Perfectly clean and healthy.

Observations in Dyar orchard, June 2nd. Grimes, Bordeaux plot—Grimes plot sprayed with standard Bordeaux shows much spotting, yellowing and dropping of foliage caused by the spray mixture, fully 60 percent of the foliage being affected more or less seriously. Apparently much of the newly set fruit was destroyed by the same agency, as thousands of little apples have shrivelled and dropped, or are showing the characteristic brown, shrunken sides where the Bordeaux has burned them.

Grimes. Lime-sulfur plot—The Grimes plot sprayed with commercial lime-sulfur shows no injury whatever from spraying; on the other hand the lime-sulfur sprayed trees seem to have been really invigorated by this mixture, as the foliage is clean, luxuriant and of excellent color. The little apples, while not a full crop (some of the trees not having blossomed and some having blossomed only on part of the branches) are plump, bright and growing, and are persistent in remarkable degree—no dropping whatever.

Fig. 14. The dividing line between the two spray test plots of Grimes Bordeaux plot at the right; lime-sulfur plot at left. Note the difference in density of foliage. Dyar orchard.

Ben Davis. Bordeaux plot—The Ben Davis plot sprayed with Bordeaux is very seriously injured, fully 90 percent of the foliage being affected. The little apples are disappearing rapidly, presumably from the same cause.

Ben Davis. Lime-sulfur plot—Foliage free from injury. The leaves, while not large, are clean, healthy, and bright in color. The little apples are fair, smooth and growing rapidly. Promise of as great a crop as the trees can support.

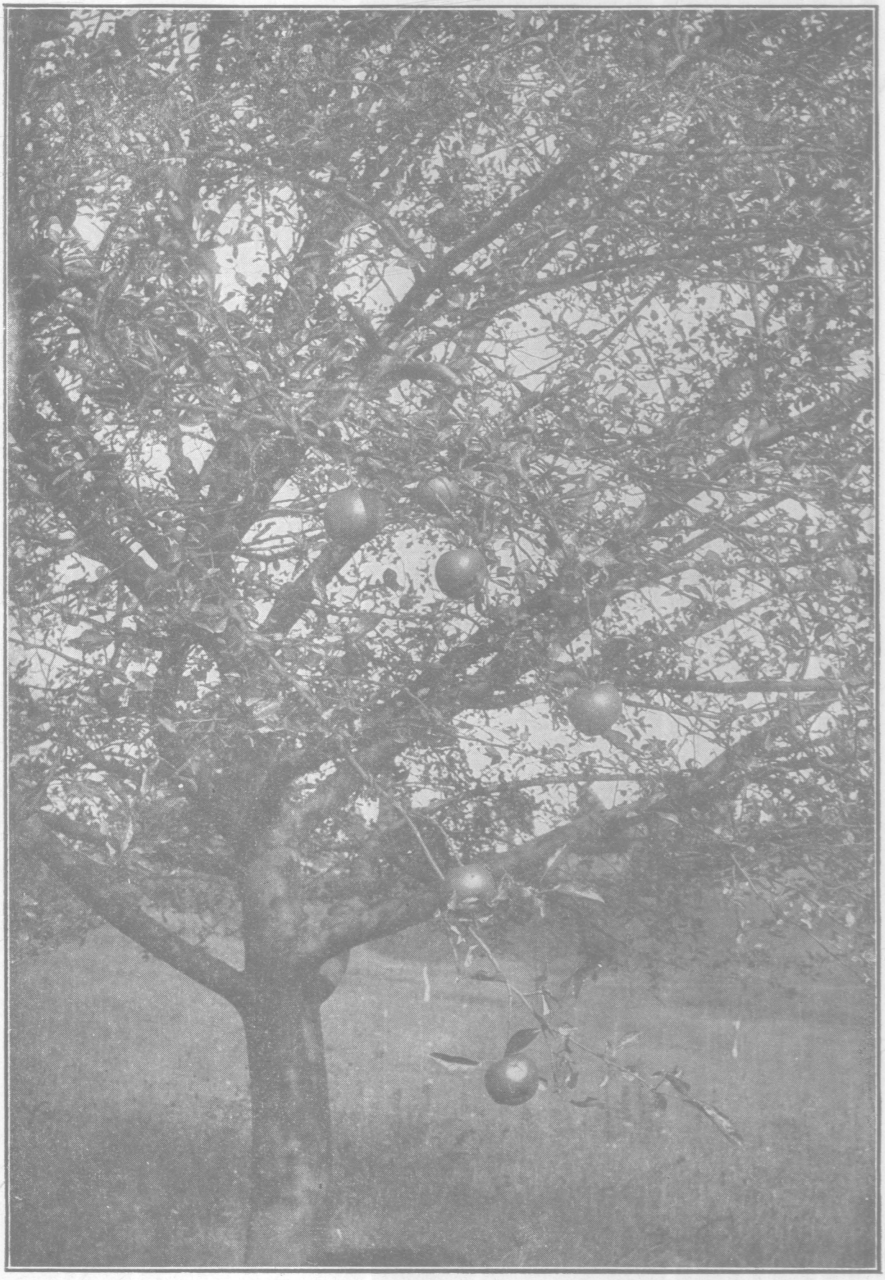


Fig. 15. Appearance of average Grimes tree sprayed with Bordeaux mixture. Dyar orchard. Note thin foliage and scarcity of fruit.

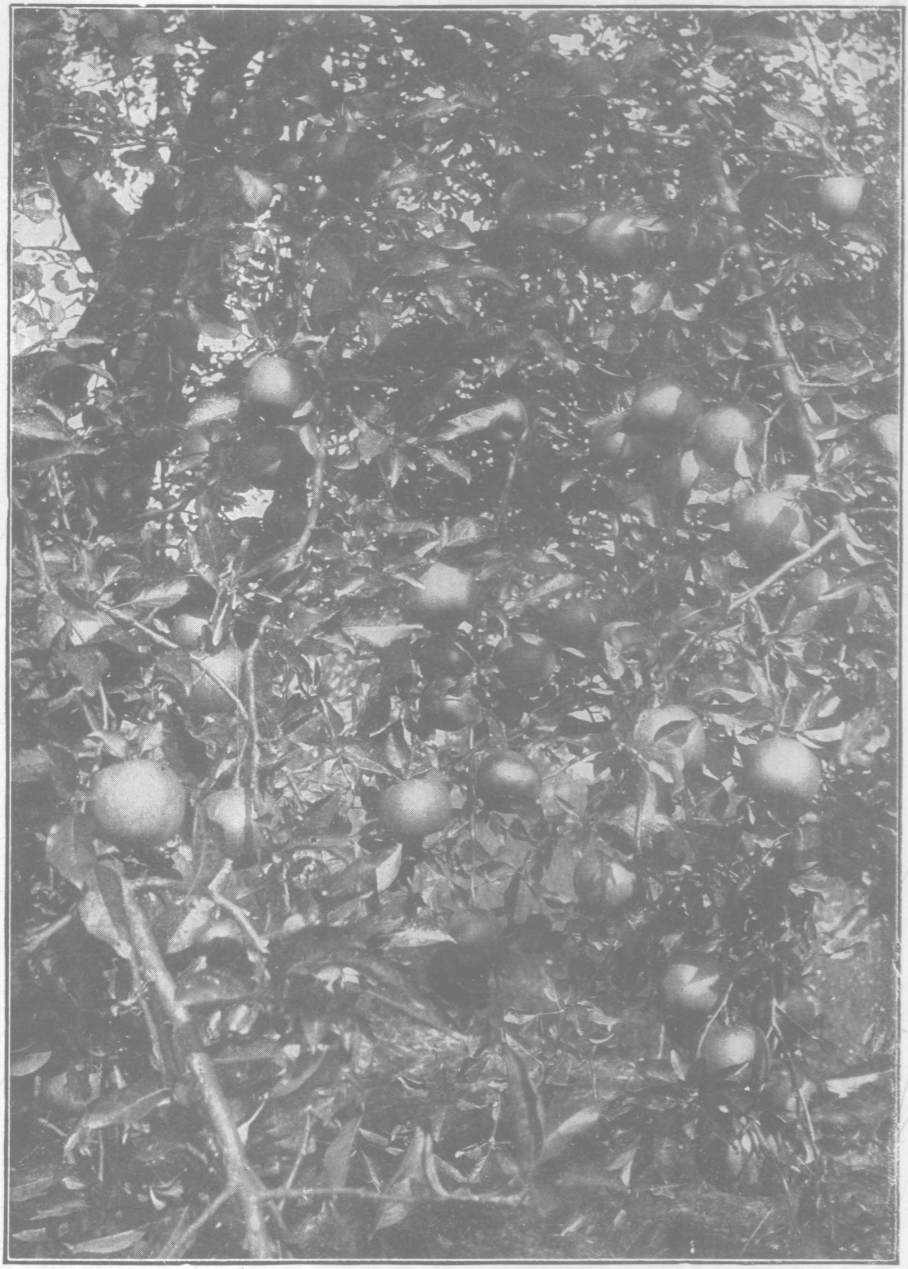
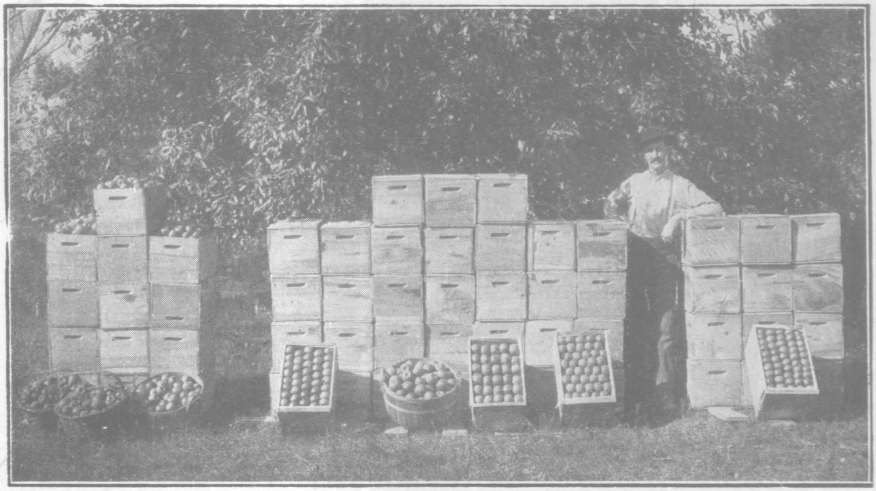


Fig. 16. Appearance of average Grimes tree sprayed with lime-sulfur, Dyar orchard. Note luxuriant foliage and prolific fruiting.

Drops and Culls No. 1. No. 2.

Fig. 17. Total crop of Grimes from Bordeaux sprayed plot. Dyar orchard.



Drops and Culls. No. 1. No. 2.

Fig. 18. Total crop from lime-sulfur sprayed plot of Grimes. Dyar orchard.

That the promise of June was fulfilled at apple picking time the following figures, giving the actual production of apples in bushels, from the various plots, will certainly demonstrate:

Grimes plot sprayed with standard Bordeaux	6 1-5	Bus.
Grimes plot sprayed with lime-sulfur	63	"
Ben Davis plot sprayed with standard Bordeaux	6	"
Ben Davis plot sprayed with lime-sulfur	114	"

The plots of Grimes were of equal size as also were the plots of Ben Davis. The ground is level and the soil uniform in character—all very thin and lacking in humus. There could be no possible difference between the two plots of either variety except as it was developed through the use of different spray mixtures. All plots were sprayed the same day at each of the three sprayings.

Both Grimes and Ben Davis from the Bordeaux sprayed plots were so russeted by the spray that they were rendered almost unfit for market. The lime-sulfur sprayed fruit was practically all of excellent market quality.

To enable the reader to more readily grasp the actual results in this most wonderful outcome of the comparison of the two spray mixtures, the fruit from the Grimes plots was very carefully graded and boxed in bushel boxes ready for market. The different lots were then arranged for photographing, with results as shown in the pictures which are presented herewith. Full explanation is given beneath each of the two photographs.

Had the products of the two Ben Davis plots been graded, boxed, arranged and photographed likewise a still greater difference in favor of the lime-sulfur spray would have been shown; but as the Ben Davis were not put on the market in boxes, as were the Grimes, no effort was made to secure photographs which would only show, on a somewhat larger scale, what the photograph of the Grimes products fully presents.

SUMMARY OF WORK BY ORCHARD OWNERS IN WASHINGTON AND EASTERN ATHENS COUNTIES IN 1910

Previous to 1909, when the work of the Experiment Station in south-eastern Ohio was begun, practically no spraying had been done in this section. There was a general lack of interest in orchard work, as has been fully explained.

Three spraying experiments were conducted by the Station in 1909, the results of which were seen and studied by many orchard owners, who became very much awakened to the possibilities of their orchards, and began at once to plan for improvement.

At the close of the season of 1910 an effort was made to determine approximately what had been accomplished by these private growers as the result of the lessons observed in 1909. With this purpose in view a canvass of Washington, as well as of a small area in eastern Athens county, was made. It was desired in this canvass to determine not only the product from sprayed apple orchards, of the season of 1910, but, so far as possible, the average product per year, for the past ten years, of the same orchards.

It was not a difficult matter to get the figures for 1910, but to secure estimates from the orchard owners of the product of the past ten years, was by no means easy or satisfactory. The usual answer given to the query as to the product of the past ten years was "*very little fruit and of very poor quality.*"

However, of 117 orchards which were sprayed by their owners in 1910, there are 57 whose owners made definite statements as to yields for the past ten years. This number has served as a fair basis for computing the product of the whole number.

The following statement gives, approximately, the data secured:

Number of orchards reported sprayed in Washington and eastern Athens counties in 1910	117
Number of bushels of apples produced in these 117 orchards, 1910	63,700
Number of bushels of apples produced in same orchards, 1900-1909 per year	4,446
Gain by spraying, in 1910, over average for ten years, bushels	59,254

While the gain by spraying, in 1910, was marvelous, it should be borne in mind that the cold of April and May entirely cut off the crops in many of the orchards. Had it not been for this heavy loss the crops of 1910 would have been very much greater. Neither is the list of orchards of which records were obtained a complete one. A number of small, widely scattered orchards, outside of the principal orchard areas of the section in which the station operated, would increase the total production considerably. The most important orchards are included, however.

While figures which tell a story so interesting as that above recorded cannot fail to impress the reader with the importance of improved orchard management, the many written and verbal reports of success reaching the Station are even more interesting and pleasing. It is to be regretted that many of these gratifying reports cannot be included in this Bulletin. The following are fairly representative:

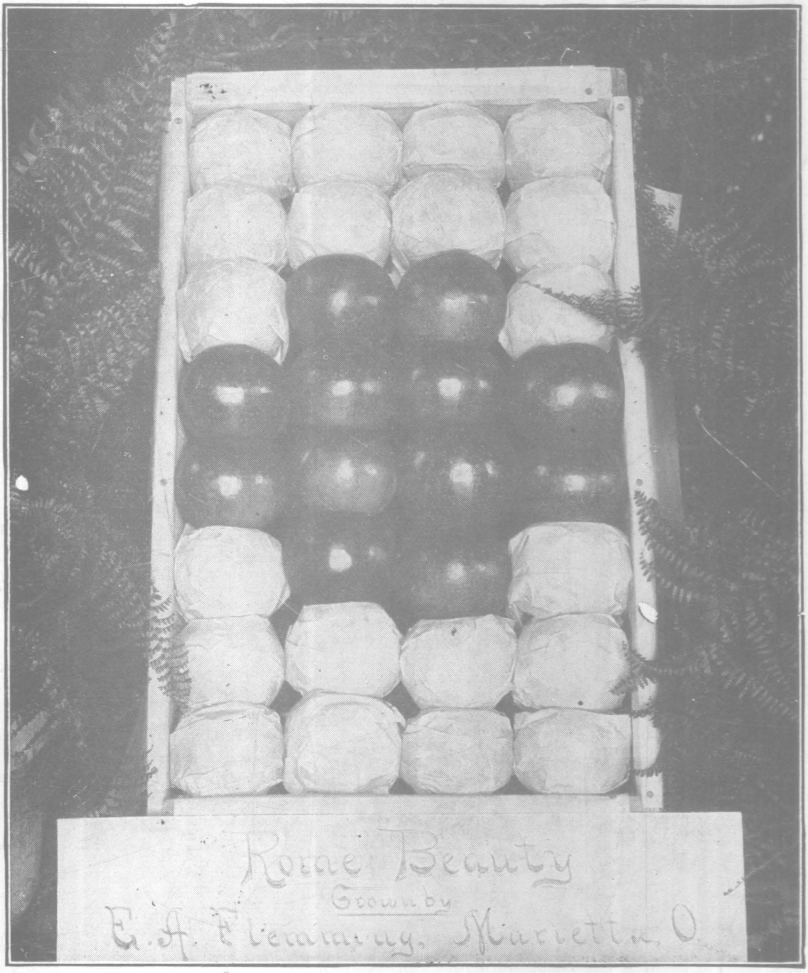


Fig. 19. A box of Washington county Rome Beauties, grown in an orchard reclaimed from a wilderness of locust sprouts, brambles and all manner of wild growth, in 1910. Mulching and spraying, after a thorough renovation, accomplished this result.

Chas. W. Oakes, during the winter of 1908-9, was making an effort to find some one to cut down and clear away his beautiful 34 year old Rome Beauty apple orchard of 350 trees. The Experiment Station sent a representative to the Oakes farm and prevailed upon Mr. Oakes to retain the orchard another year, until an experiment in spraying could be conducted. One acre was staked off and included in a spray test with the result that this acre netted Mr. Oakes $474 in 1909.

The orchard was spared. The trees were given a thorough pruning and the taller ones headed down considerably, so that spraying could be more easily done. A new power sprayer was purchased during the winter of 1909-10.

This orchard netted Mr. Oakes over $3,100.00, in 1910; and he has made the statement to the writer that he would not exchange this once supposed worthless orchard for the best farm in Washington county.

Mr. E. A. Fleming forwarded to the office of the writer, in November, a sample bushel box of Rome Beauty apples grown in an orchard purchased in 1909, which he has reclaimed from a wilderness of young locust and sassafras trees, blackberry bushes and all kinds of wild growth. Many of the trees were mulched and all were sprayed during the spring of 1910. Mr. Fleming gathered a fair crop of sound apples, and the orchard of 1700 trees promises to promptly pay for the entire farm. It is difficult to believe that such beautiful fruit can be so promptly secured from an orchard existing under such trying conditions; but the photograph shown herewith is evidence of the wonderful results achieved.

Washington county is the section of Ohio in which the Roxbury Russet was first introduced, it having been brought from Roxbury, Mass. This variety, in the early days of Ohio horticulture, was most successful in the valley of the Ohio; but within recent years it had failed to bear and was thought to be of no further value.

A considerable orchard of very old and large Roxbury trees, located in the edge of the little town of Belpre, opposite Parkersburg, was leased by Mr. William Coe, of Belpre, and thoroughly sprayed. Over 800 barrels of as fine Roxburys were produced in this orchard in 1910 as were ever grown in the valley of the Ohio.

Mr. John O'Neal, with whom the Experiment Station had a small spraying experiment in 1909, and who had gathered no perfect fruit from his Rome Beauty orchard for several seasons prior to that year, succeeded in securing a crop of 790 bushels in 1910. Because of the extremely dry weather and the overloading of the trees the apples were not large, but were sound, of good color and of fine flavor.

Mr. O'Neal stated, in 1909, that he had never expected again to gather a perfect apple from this orchard, as for several years the fruit had been so defective that not enough for family use was produced.

The fine Rome Beauty orchard of Mr. A. T. Dye blossomed beautifully in the spring of 1909. It was unsprayed and but a couple of barrels of very scabby, inferior apples, were "poled off" in

the autumn. The same orchard was sprayed in the spring of 1910 with the result that 1100 bushels of fine, smooth, sound apples were harvested in the autumn.

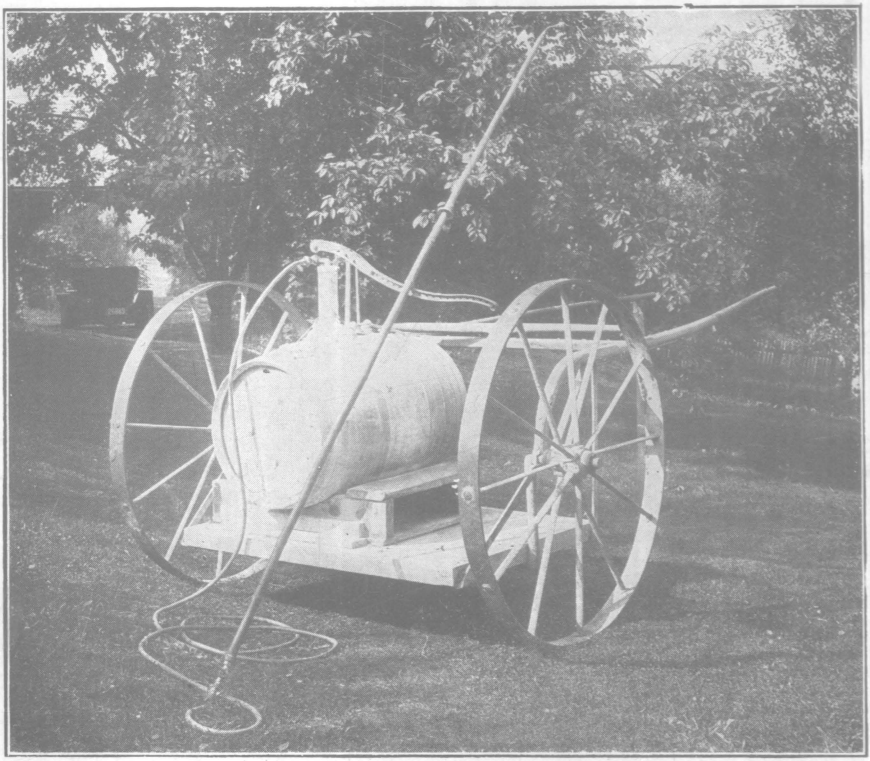


Fig. 20. An excellent form of spray outfit for a small place or rough-steep ground. Cannot be upset, no matter how sloping the ground. Spray cart designed by the writer and used at "Dale View" in Licking County. Can be made by any Metal Wheel Company.

Scores of similar examples of the benefits of spraying are known to the writer, as having developed in the season of 1910, but these five illustrations are sufficient because typical. Each orchard owner who succeeded in saving his crop of apples in 1910 has not only proved to his own satisfaction that he need no longer fear the various forms of fungi and insect life which have so long destroyed his crops of fruit, but his success in combating these pests constitutes an object lesson to his neighbors. These lessons have become firmly rooted. Their influence will live and grow.